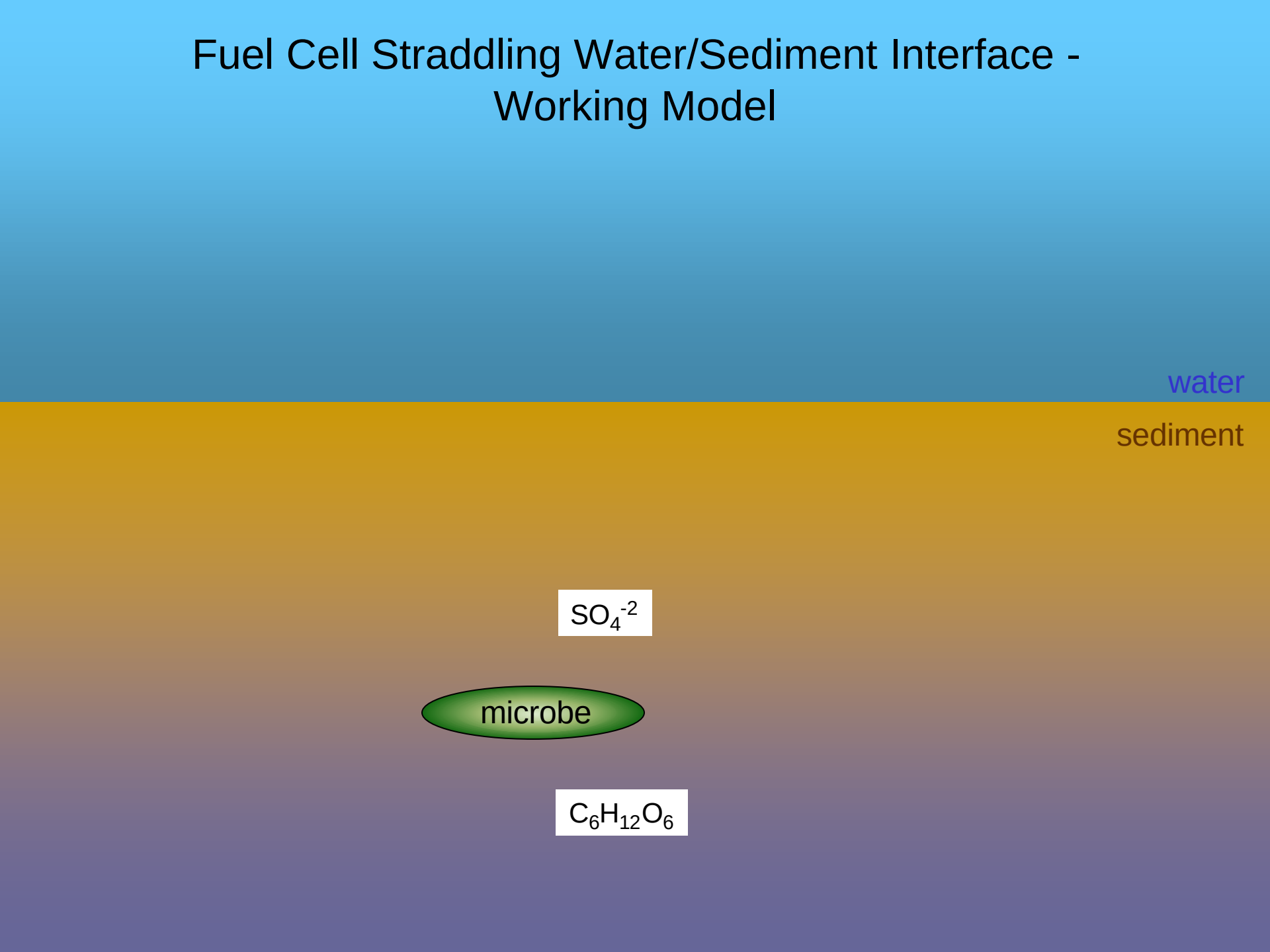
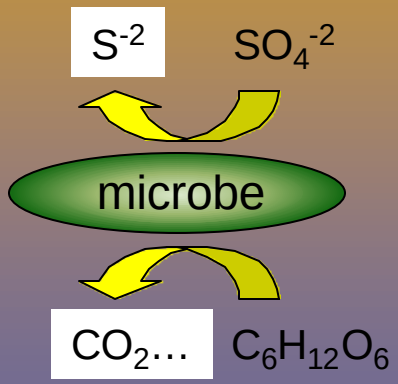
Fuel Cell Straddling Water/Sediment Interface - Working Model



Fuel Cell Straddling Water/Sediment Interface - Working Model

water

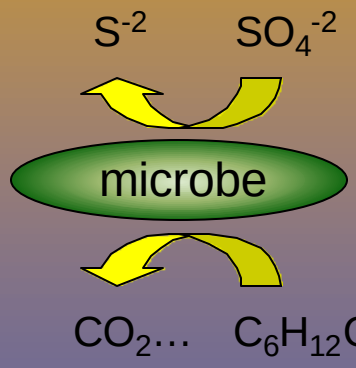
sediment



Fuel Cell Straddling Water/Sediment Interface - Working Model

water

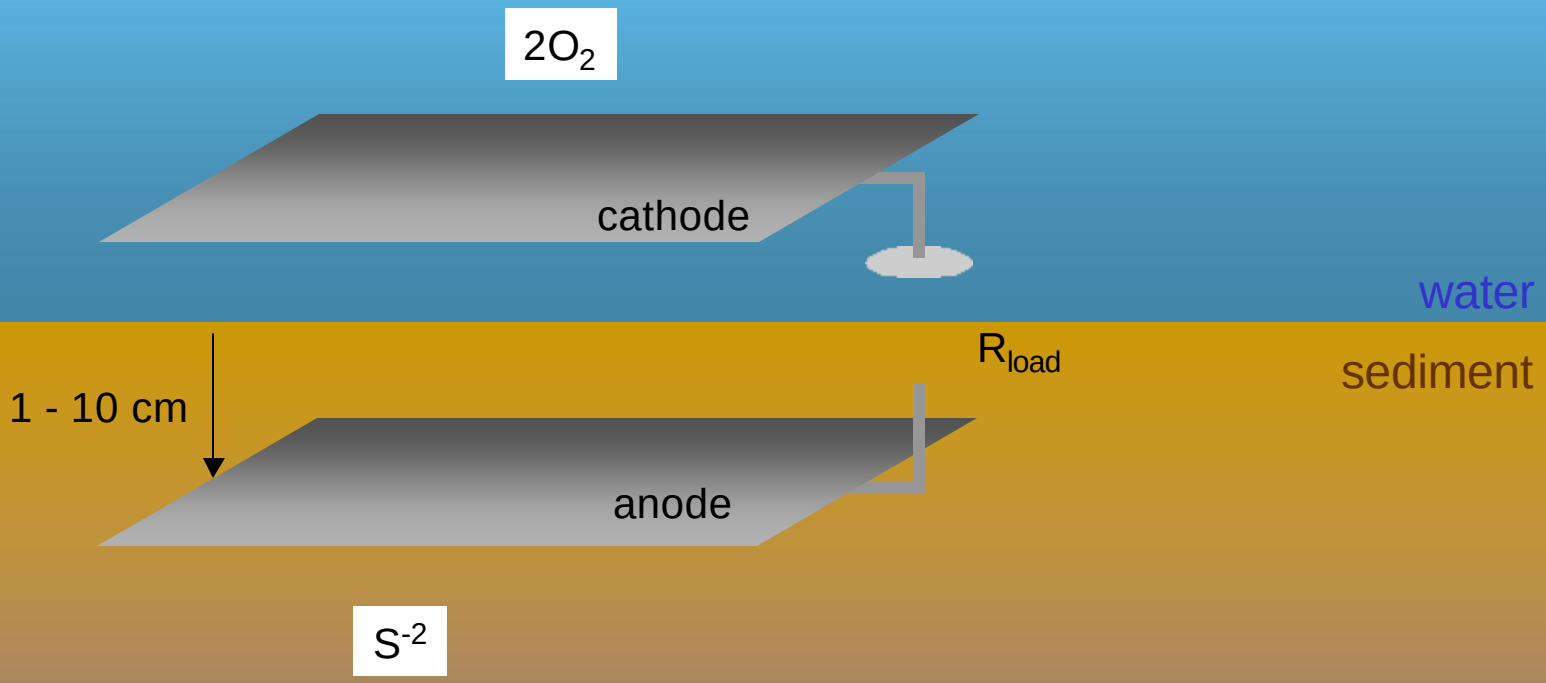
sediment



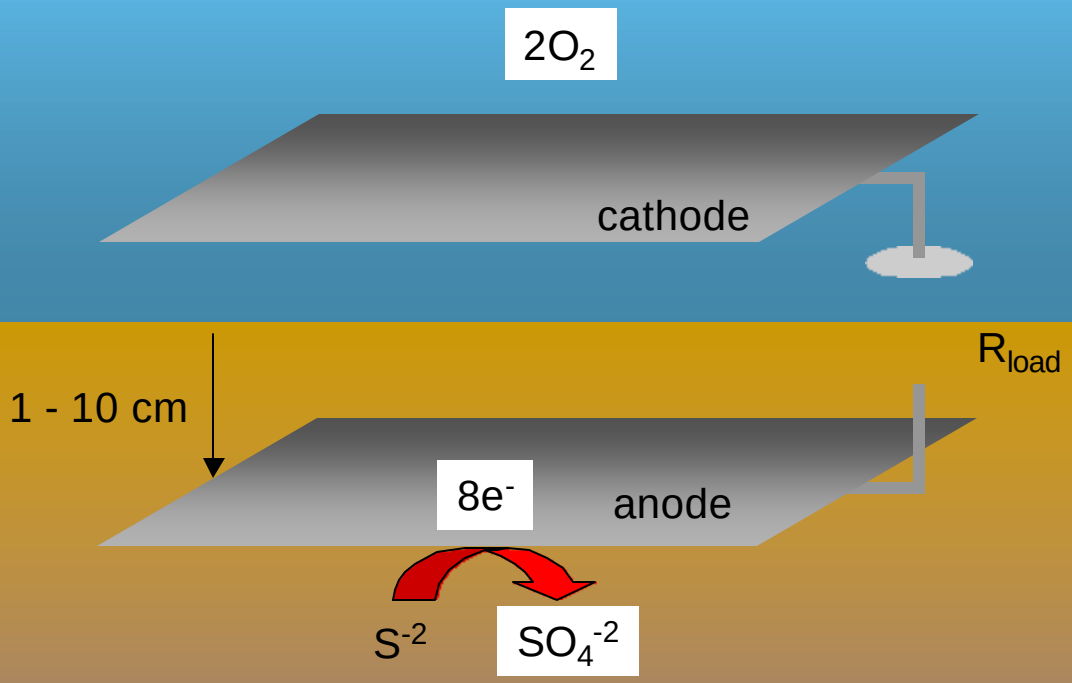
$$C_6H_{12}O_6 + SO_4^{-2} \rightarrow CO_2 + S^{-2} + 106H_2O$$

$$\Delta G^o = -6{,}720 \text{ kJ}$$

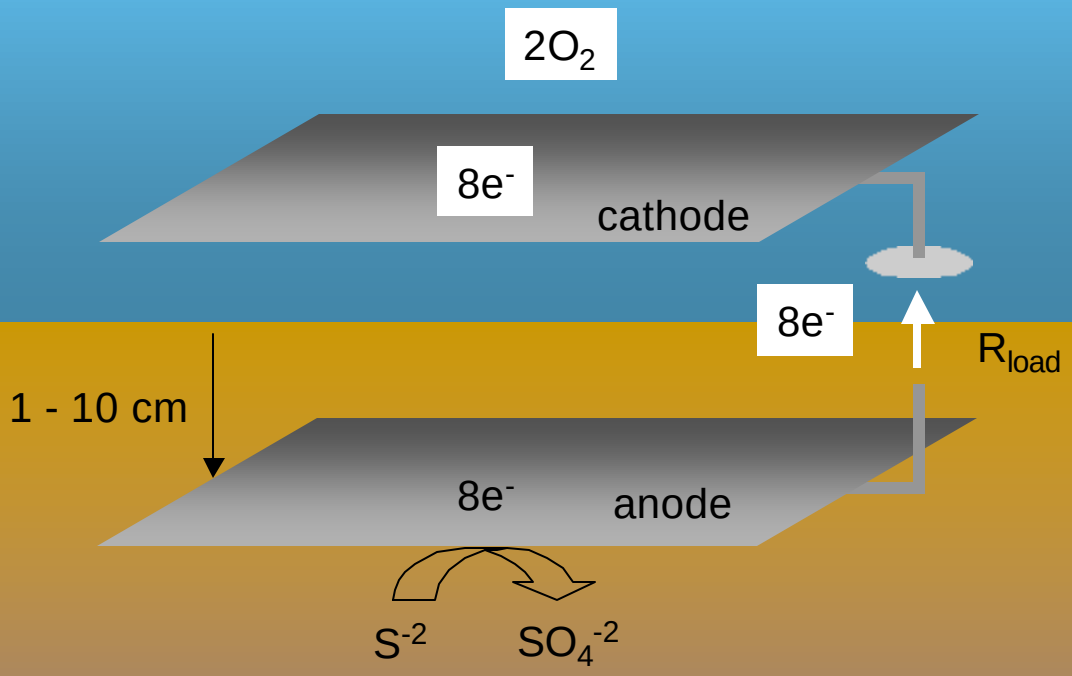
Fuel Cell Straddling Water/Sediment Interface - Working Model



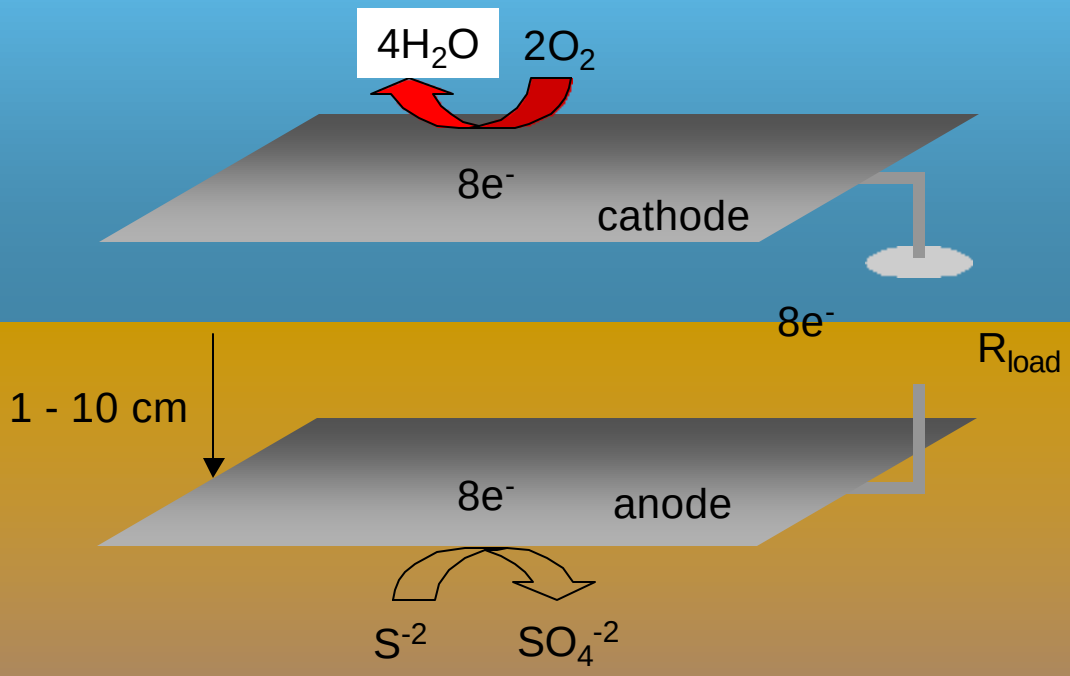
Fuel Cell Straddling Water/Sediment Interface - Working Model



Fuel Cell Straddling Water/Sediment Interface - Working Model



Fuel Cell Straddling Water/Sediment Interface - Working Model

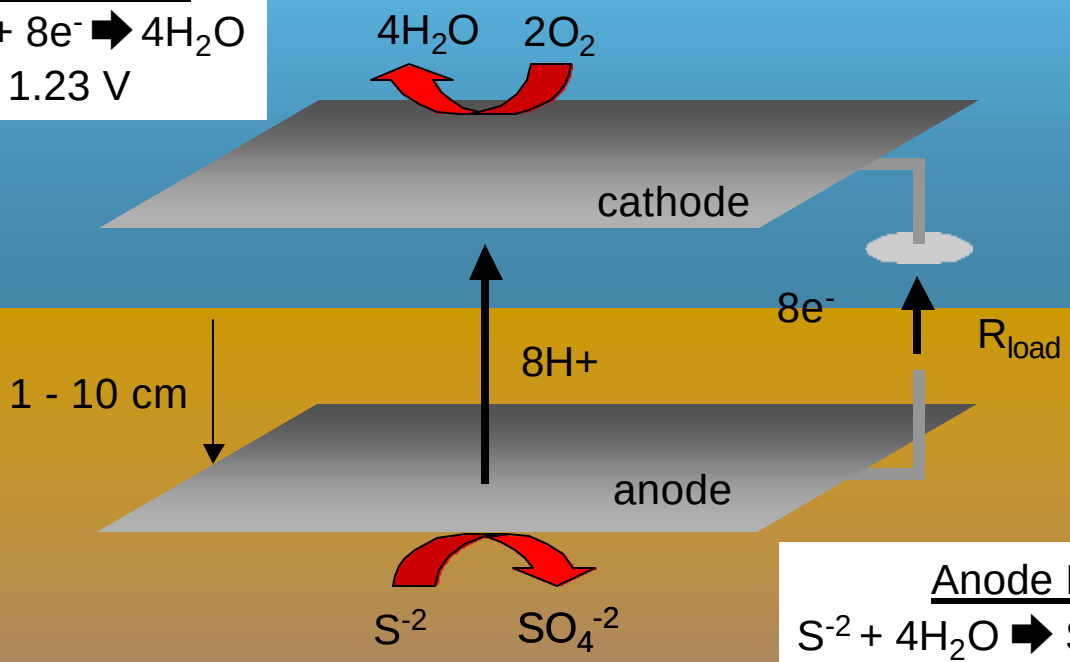


Fuel Cell Straddling Water/Sediment Interface - Working Model

Cathode Reaction:

$2O_2 + 8H^+ + 8e^- \rightarrow 4H_2O$

$E^o = 1.23$ V



Net Cell Reaction:

$S^{-2} + 2O_2 \rightarrow SO_4^{-2}$

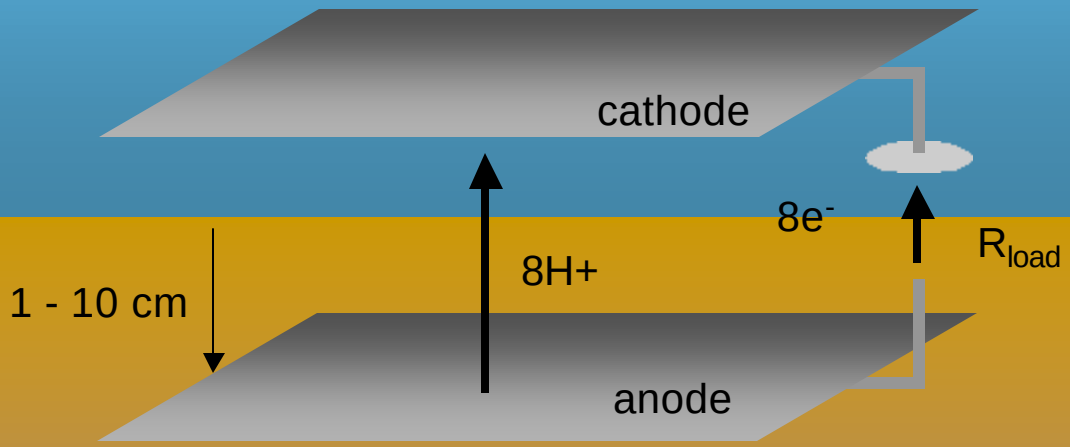
$E^o = 1.08$ V

Anode Reaction:

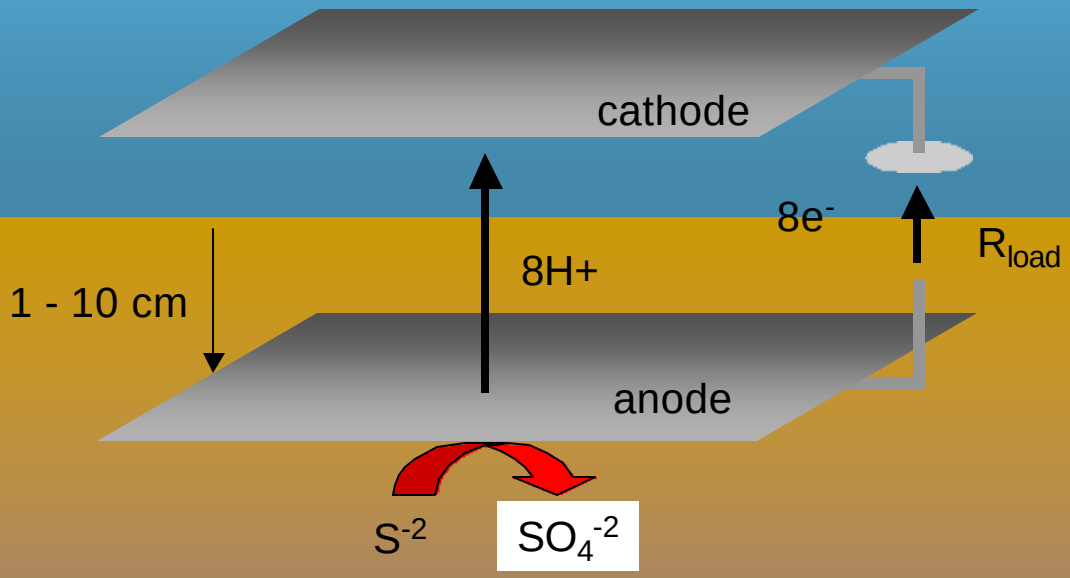
$S^{-2} + 4H_2O \rightarrow SO_4^{-2} + 8H^+ + 8e^-$

$E^o = -0.15$ V

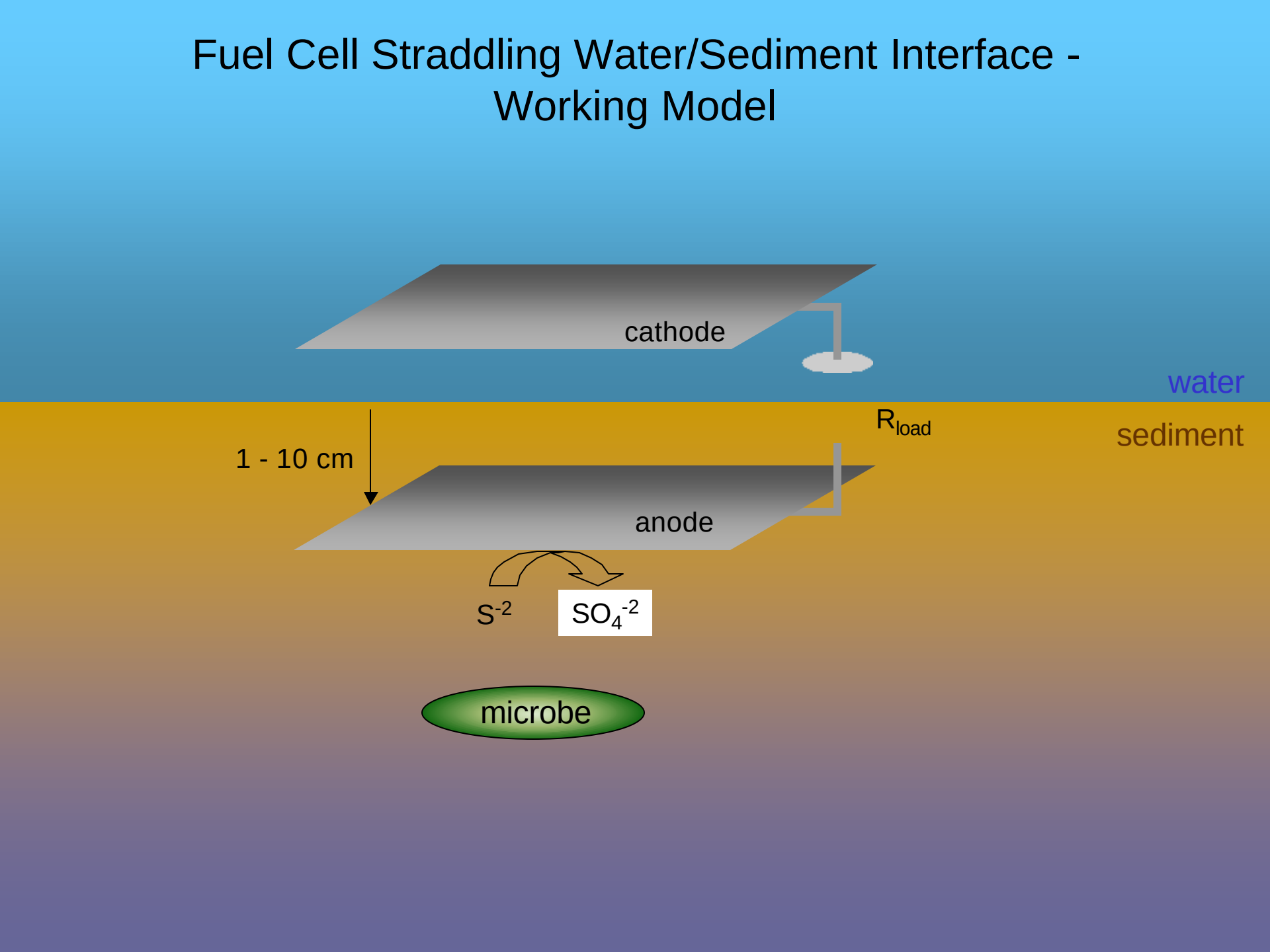
Fuel Cell Straddling Water/Sediment Interface - Working Model



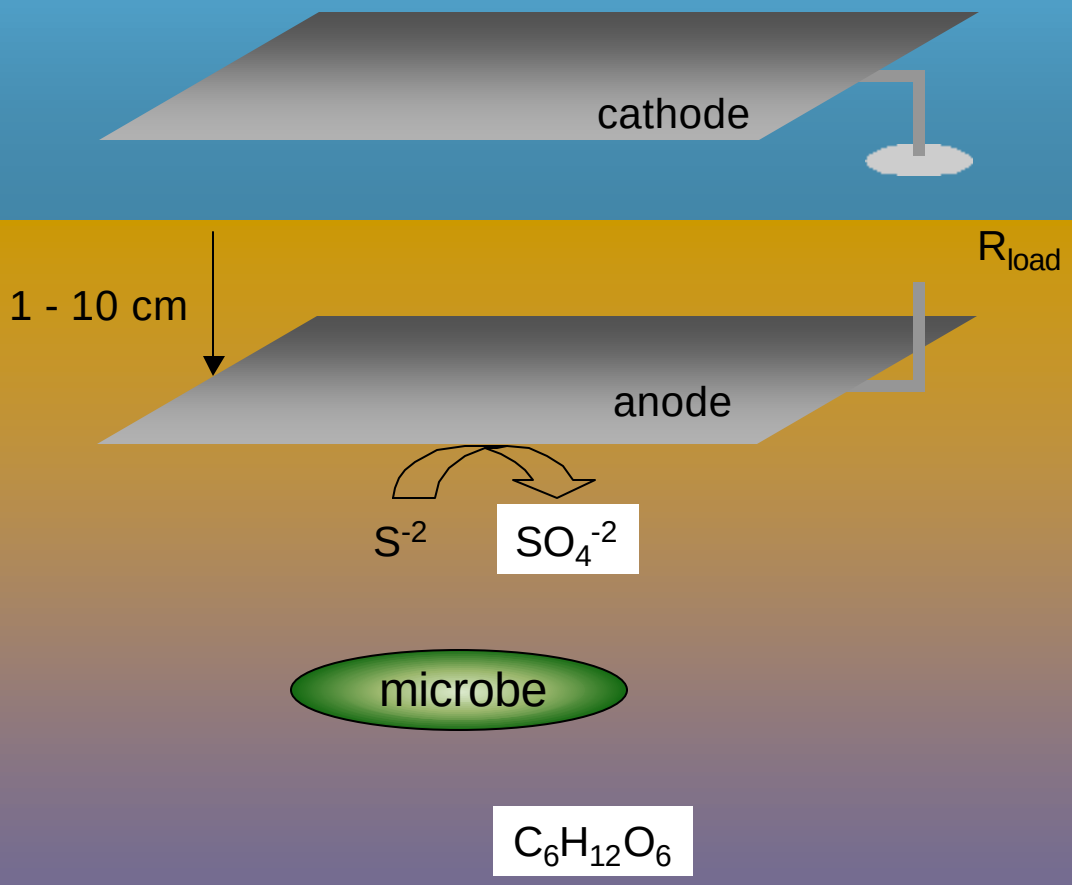
Fuel Cell Straddling Water/Sediment Interface - Working Model



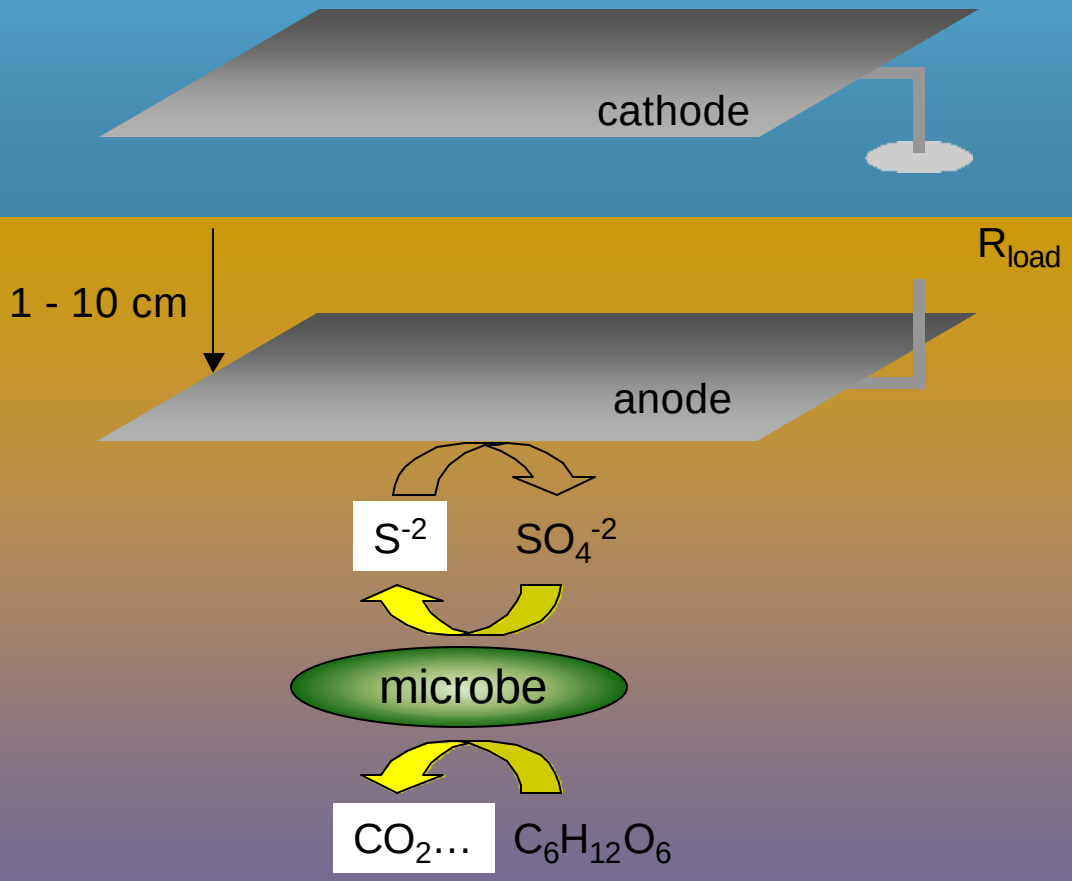
Fuel Cell Straddling Water/Sediment Interface - Working Model



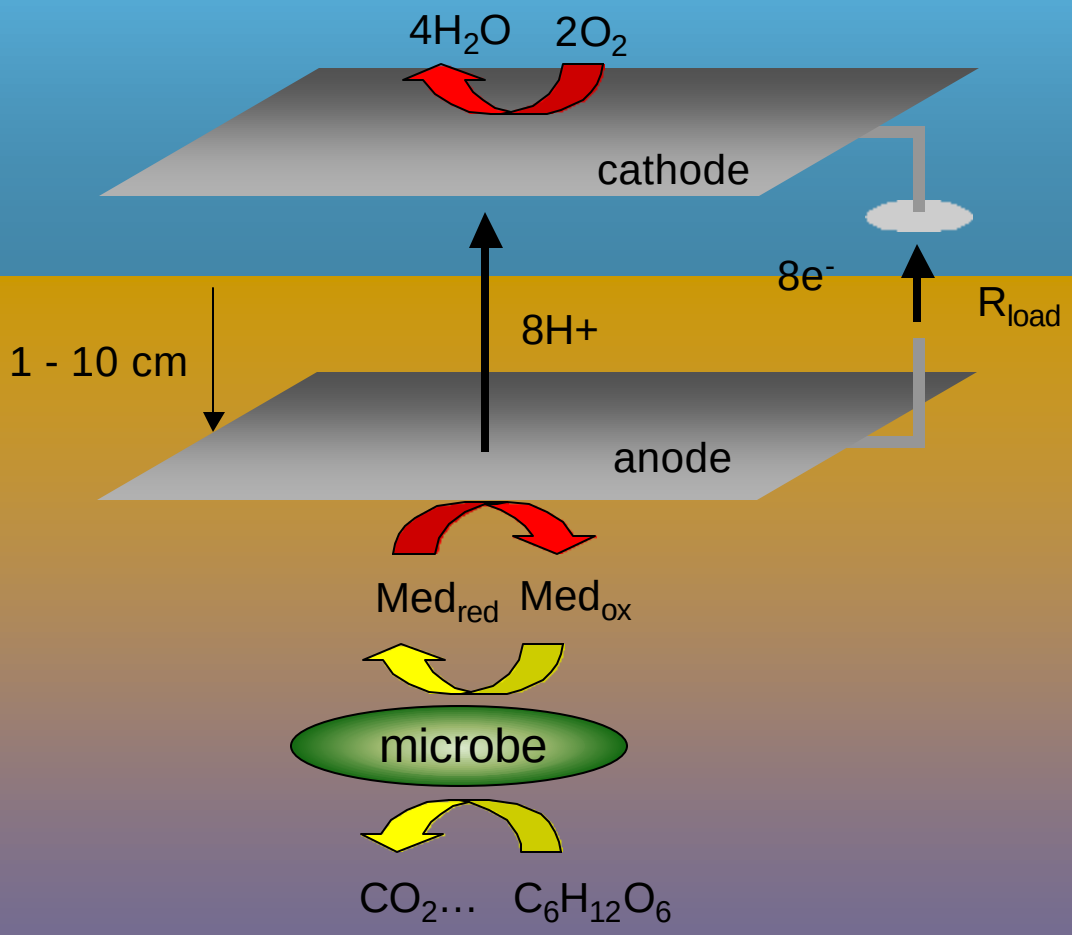
Fuel Cell Straddling Water/Sediment Interface - Working Model



Fuel Cell Straddling Water/Sediment Interface - Working Model



Fuel Cell Straddling Water/Sediment Interface - Working Model



How Much Energy Can be Harvested ?

water

sediment

MARINE SEDIMENTS AS FUEL SOURCES

- typical coastal marine sediments contain ~ 0.5 moles/liter reduced carbon (`2% dry weight)

- energy densities of typical coastal marine sediments are ~10 mWatt-Year/liter (188, 72, and 8.5 mWatt-Year/liter for lithium, alkaline,and lead-acid battery)

- can be replenished by sedimentation and bioturbation

SEAWATER OXYGEN AS OXIDANT

- typical sea water contains ~ 200 μmoles/liter of oxygen
- replenished by mass transfer
- used by seawater batteries - sustains 1-5 Watts

water

sediment

Current and Near-Future Activities

- Detailed kinetic and thermodynamic investigation of electrode reactions for various electrode materials
- Elucidate microbial aspect of energy harvesting mechanism
- Deployment of meter-dimensioned prototypes in various marine environments
- Investigation of benthic methane-hydrate as a fuel source.
- Investigation of benthic remediation

Acknowledgments

•Dr. Harold Bright (ONR)
•Dr. Robert Nowak (DARPA)
•NRL

Return to Agenda

Next Presentation